TC 0080-06

FINAL REPORT
REMEDIAL INVESTIGATION

INDIAN VILLAGE WASTE WATER TREATMENT SYSTEM

CAMP NAVAJO
BELLEMONT, ARIZONA

July 1999

Prepared for:

US Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

and

Arizona Army National Guard
Camp Navajo
Bellemont, Arizona 86015-5000

Prepared by:

Tetra Tech, Inc.
180 Howard Street, Suite 250
San Francisco, California 94105-1617

REMEDIAL INVESTIGATION
AT
CAMP NAVAJO

INDIAN VILLAGE WASTE WATER TREATMENT SYSTEM

FINAL REPORT

Contract DACA05-93-D-0019

PREPARED BY:

TETRA TECH, INC.

Approved by:	______________________________ Bradley S. Hall, RG Tetra Tech, Inc. Project Manager	____________ Date
Approved by:	______________________________ Maynardo Aala US Army Corps of Engineers, Sacramento District Technical Manager	____________ Date
Approved by:	______________________________ Guy Romine National Guard Bureau, Installation Restoration Program Manager	____________ Date

TABLE OF CONTENTS

Section Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

List of Acronyms

Acronym	Full Phrase
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Heath Services
AWQS	Aquifer Water Quality Standard
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
LDC	Laboratory Data Consultants
MK	Morrison Knudsen Corporation
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
RI	remedial investigation
RPD	relative percent difference
SS	surface soil
SSL	soil screening level
SW	surface water
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
WC	waste characterization

SECTION 1
INTRODUCTION

1.1. PURPOSE OF REPORT

This report summarizes the results of the remedial investigation conducted at the Indian Village Wastewater Treatment System (NAAD 28, NADA 28, AREE 28) (IVW) at Camp Navajo (formerly Navajo Depot Activity), in Bellemont, Arizona (Figure 1-1). Tetra Tech was retained by the United States Army Corps of Engineers (USACE) to conduct the work described in this report.

1.2. SITE BACKGROUND

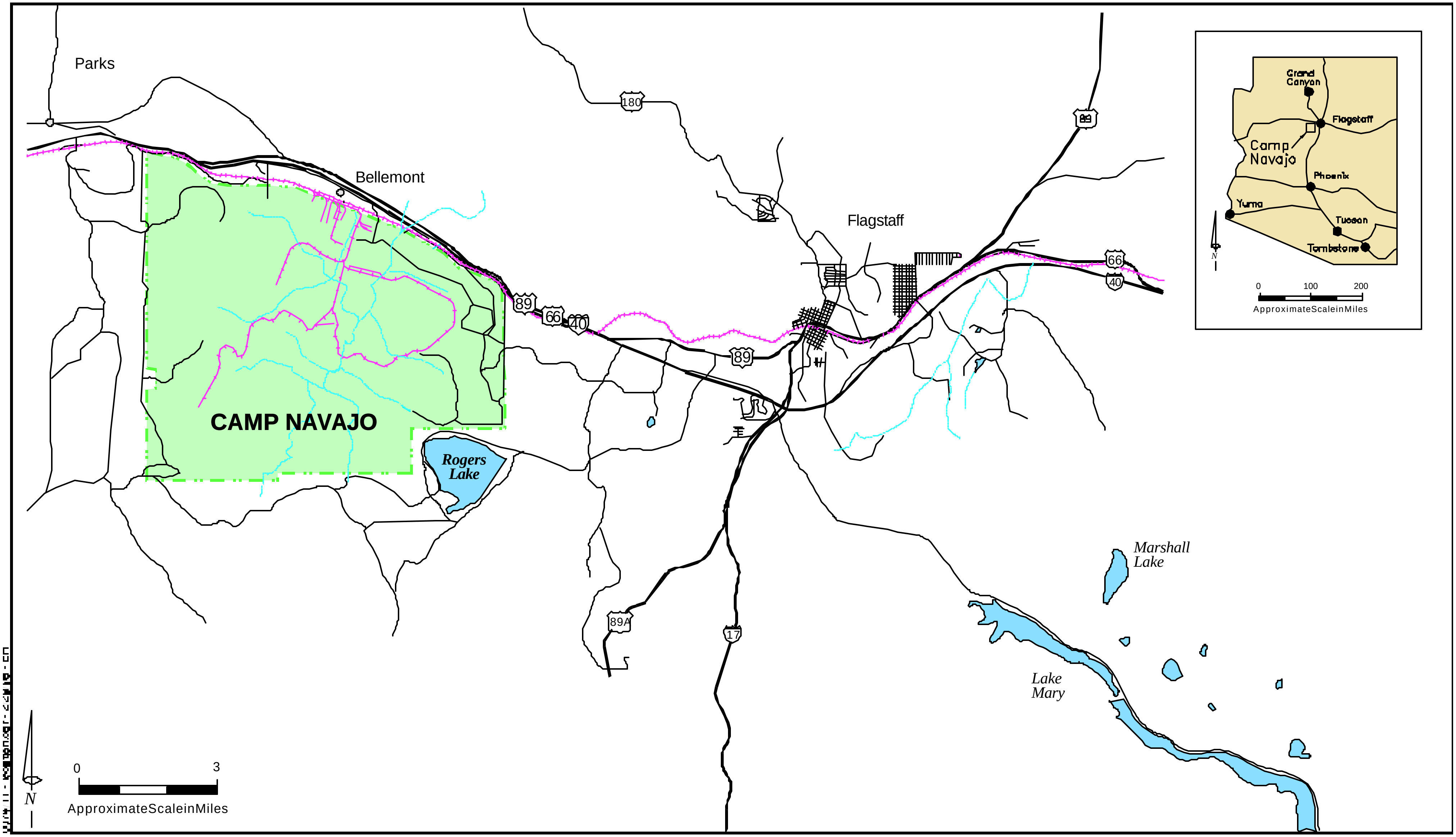
1.2.1. Site Description

The IVW is located along the patrol road south of Gate 7A (Figure 1-2), to the northeast of igloo area G, (Figure 1-3). An inactive concrete Imhoff tank provided filtration of domestic sewage wastewater generated by the former Navajo and Hopi workers' villages. A gravel leach field, connected to the Imhoff tank and bermed with concrete practice bombs, is located directly south of the Imhoff tank. Three former sewage evaporation lagoons, all unlined, were used from the 1940s to 1971 to hold effluent from the Imhoff tank and untreated sewage from the Indian Village (USAEHA 1988; EBASCO 1990). After settling, sludge periodically was removed from the Imhoff tank and disposed of at the sanitary landfill, NAAD 40 (Uribe 1993a). The area of each lagoon ranges from about 0.7 to 1.0 acre. All three lagoons typically contain water during the wet season; during the dry season, the two northern lagoons usually become dry and overgrown with vegetation.

1.2.2. Previous Investigations

The *Groundwater Contamination Survey* (USAEHA 1988) reported that two of the three lagoons were dry. The southern lagoon contained a small amount of water used for stock watering.

No investigations have been conducted at the IVW.



CampNavajoisinnorthcentralArizona
about12mileswestofthecityofFlagstaff.

LEGEND:

Highways

Roads

Railroad

Rivers/Streams

Camp Navajo Location Map

Camp Navajo
Bellemont,Arizona

Figure 1-1

Tetra Tech, Inc.

Legend:

Ditch
Fence

N

0 125 250
Approximate Scale in Feet

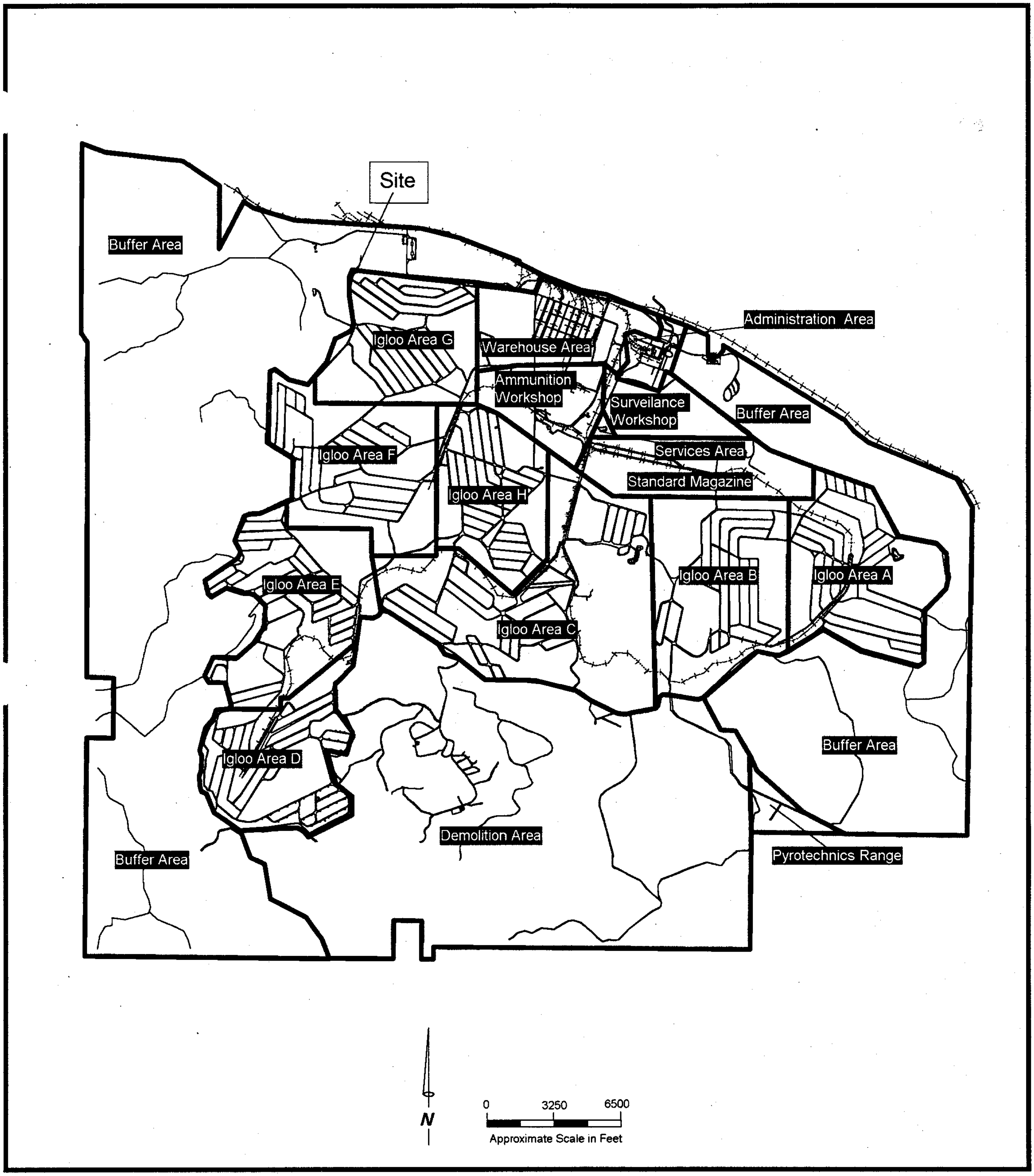
Tetra Tech, Inc.

Indian Village Wastewater Treatment System

Site Plan

Camp Navajo, Bellemont, Arizona

Figure 1-2



Indian Village Wastewater Treatment System

Site Map

Camp Navajo, Bellemont, Arizona

Tetra Tech, Inc.

Figure 1-3

1.3. STATEMENT OF THE PROBLEM

The IVW has received domestic sewage wastewater during its operation. Treatment practices previously have included filtrating of the sewage through an Imhoff tank with final disposition into either a gravel leach field or the treatment lagoons. Potential contaminants from domestic sources (metals and nitrogen compounds) may have migrated into the environment at this site.

1.4. REPORT ORGANIZATION

This report follows United States Environmental Protection Agency (USEPA) guidance for remedial investigation (RI) reports in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA 1988). Section 2 describes the field investigations conducted as part of the RI. Sections 3 and 4 present the physical and chemical results, respectively. Section 5 presents a discussion of the fate and transport characteristics of the contaminants. Section 6 presents risk screening for the identified contaminants. All results are summarized with conclusions in Section 7.

SECTION 2
SAMPLING PROGRAM

2.1. SAMPLING OBJECTIVES

The specific objectives of the investigation of the IVW are to determine if metals and nitrogen compound concentrations in standing water and sediments in the Imhoff tank, gravel leach field, and lagoons pose a potential threat to human health or the environment.

2.2. SAMPLING APPROACH

Photo documentation is provided in Appendix A. Field notes are presented in Appendix B. Field investigations were conducted in accordance with the procedures outlined in the field sampling plan provided in Appendix C. Surveyor results can be found in Appendix D.

Task 1: Surface Water

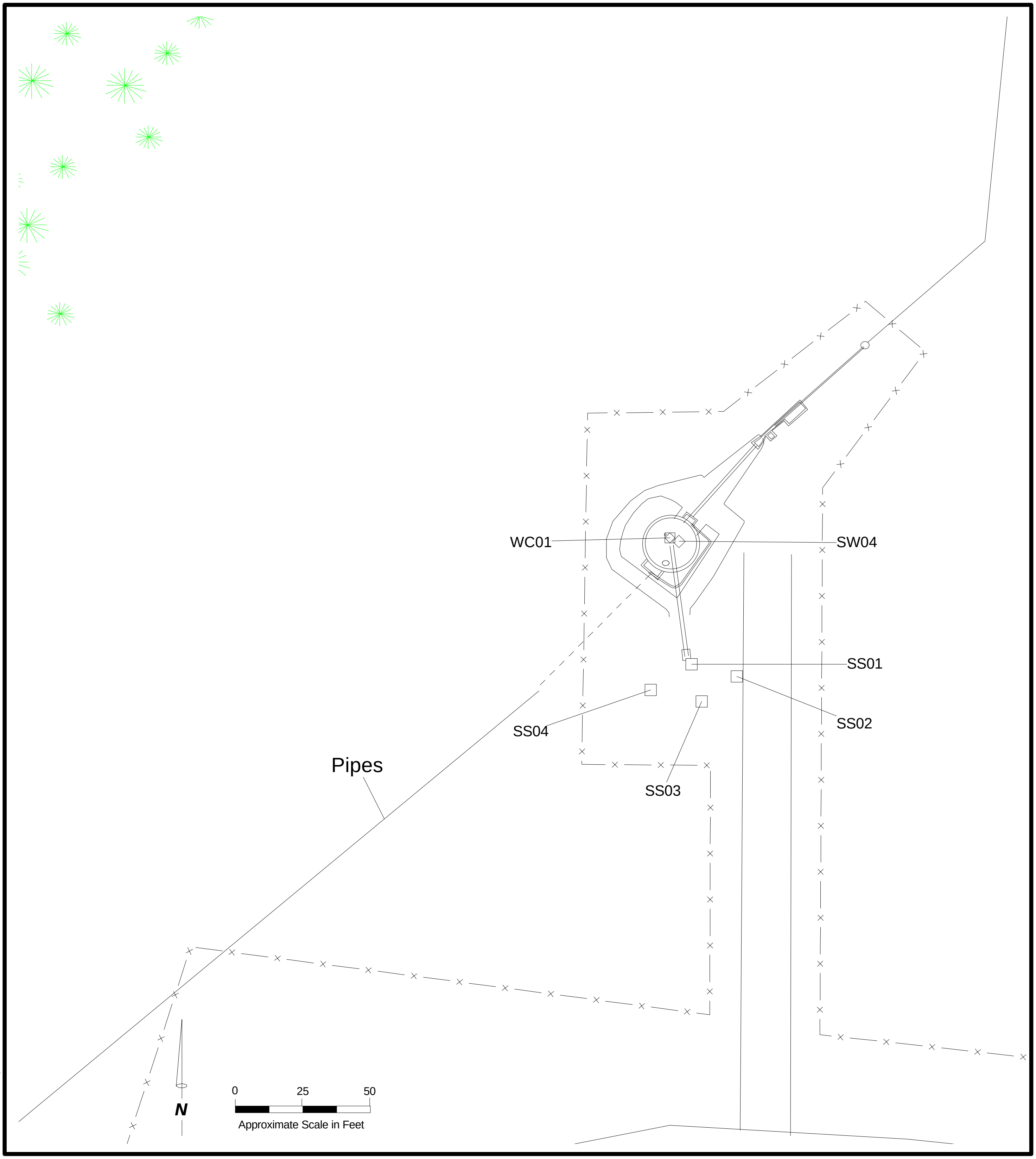
Three surface water samples were collected from the wastewater evaporation lagoons and one sample from the Imhoff tank. Sample locations are shown in Figure 2-1. All surface water samples were analyzed for metals, nitrate/nitrite, and ammonia nitrogen (Table 2-1).

Task 2: Waste Characterization

Two waste characterization samples were collected from the bottom sludge in the Imhoff tank. Figure 2-1 shows the waste characterization sampling location. The samples were analyzed for pH, metals, nitrate/nitrite, and ammonia nitrogen (Table 2-1).

Task 3: Sediment Sampling

One sediment sample was collected from the inlet area of each of the three treatment lagoons. Samples were collected by driving a 2-inch by 12-inch California modified split spoon sampler, as described in Appendix C. Figure 2-2 shows the sediment sampling locations. The samples were analyzed for percent moisture, pH, metals, nitrate/nitrite, and ammonia nitrogen (Table 2-1).



Legend:

Ditch
Subaqueous Sample
Existing Surface Soil / Sediment Sample
Existing Surface Water Sample
Fence
Trees

Indian Village Wastewater Treatment System - Imhoff Tank Investigation Plan

Camp Navajo, Bellemont, Arizona

Tetra Tech, Inc.

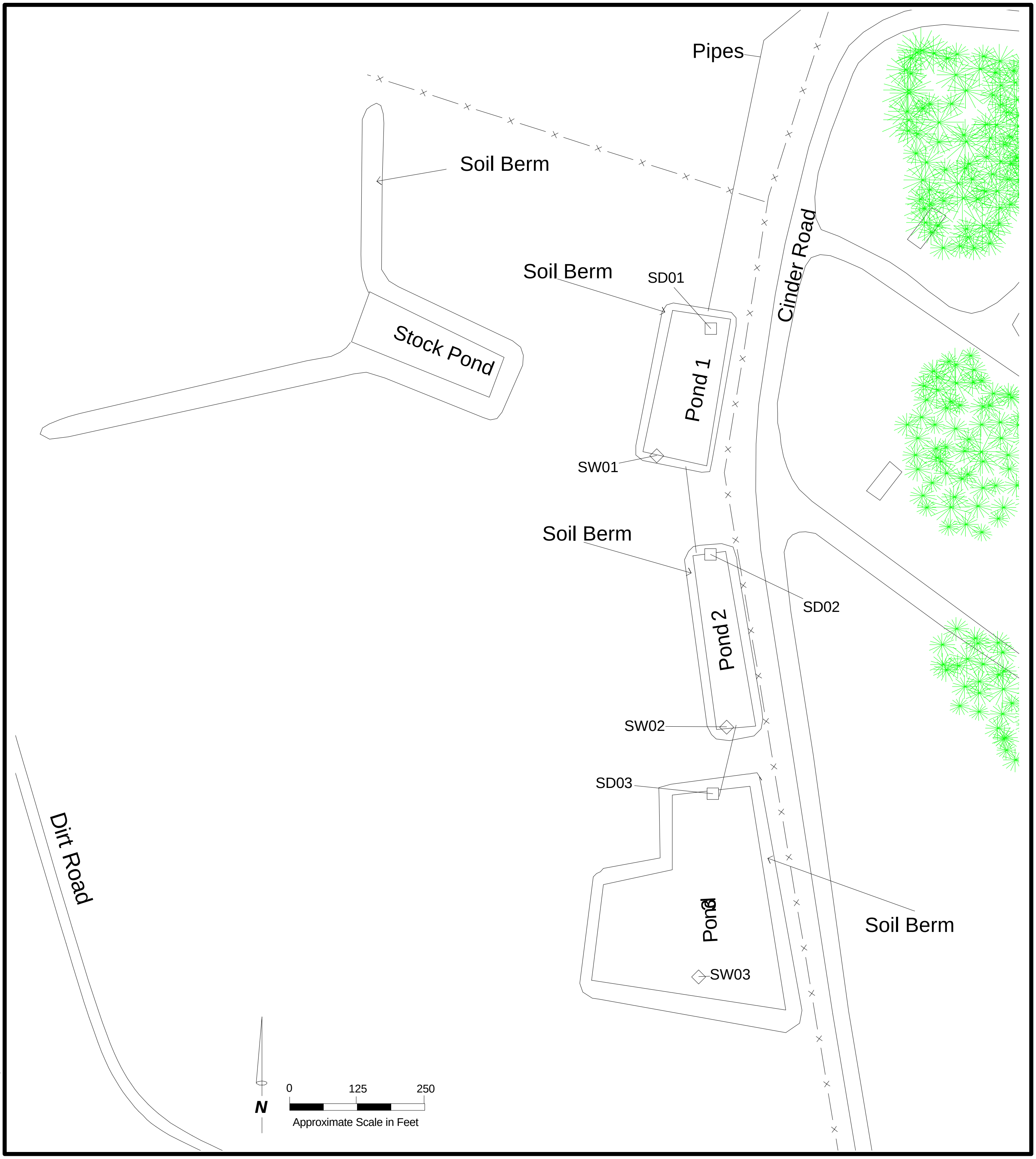
Figure 2-1

Table 2-1
Indian Village Waste Water Treatment System Sample Analyses

Sample ID	Sample Date	Depth (feet)	Media	Percent Water ASTM D2216	pH SW9045A	pH SW9045B	Dry Density ASTM D2937	Particle-Size Distribution ASTM D422	Metals SW6010A	Mercury SW7471A	Mercury SW7470A	Ammonia as N USEPA350.3	Nitrate plus Nitrite as N USEPA353.2
IVW-SD01S-01	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SD02S-01	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SD03S-01	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SS01S-01	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SS02S-01	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SS03S-01	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SS04S-01	11/4/95	1	Soil	X		X	X	X	X	X		X	X
IVW-SS05S-01*	11/4/95	1	Soil	X		X			X	X		X	X
IVW-SW03W-01	11/2/95	0	Water						X		X	X	X
IVW-SW04W-01	11/2/95	0	Water						X		X	X	X
IVW-SW05W-01*	11/2/95	0	Water						X		X	X	X
IVW-WC01W-01	11/4/95	0	Water		X				X		X	X	X
IVW-WC02W-01*	11/4/95	0	Water		X				X		X	X	X

Notes:

*	Blind duplicate sample (see section 4.5)
ASTM	American Society for Testing and Materials



Legend:

Fence
Ditch
Trees
Existing Surface Soil / Sediment Sample
Existing Surface Water Sample

Indian Village Wastewater Treatment System - Imhoff Tank Investigation Plan

Camp Navajo, Bellemont, Arizona

Tetra Tech, Inc.

Figure 2-2

Task 4: Surface Soil Sampling

Four surface soil samples were collected from the gravel leach field. Samples were collected by driving a 2-inch by 12-inch California modified split spoon sampler, as described in Appendix C. Figure 2-1 shows the surface soil sampling locations. The samples were analyzed for percent moisture, pH, metals, nitrate/nitrite, and ammonia nitrogen (Table 2-1). One sample also was analyzed for bulk density and grain size.

Task 5: Surveying

After the investigations were completed, Aztech Surveying, an Arizona-licensed land surveyor, surveyed the horizontal location of the samples. Horizontal coordinates for each location were surveyed relative to a permanent control point established on-site. Horizontal control is accurate to ±0.1 feet. Sample locations in Figures 2-1 and 2-2 are based on survey results. A table of surveyed sample locations is included in Appendix D.

2.3. SAMPLE ANALYSIS

Eight soil samples and five water samples were collected and analyzed during this investigation. Soil sample analyses conducted as part of this investigation included metals, ammonia nitrogen, nitrates/nitrites, percent water, and pH by Quanterra Laboratories in California. Water sample analyses conducted as part of this investigation included pH, metals, ammonia nitrogen, and nitrates/nitrites by Quanterra Laboratories in California. One soil sample also was analyzed for bulk density and particle-size distribution by Earth Tech Laboratories in California. Table 2-1 summarizes the samples collected and the types of analyses conducted on each sample.

SECTION 3
PHYSICAL CHARACTERISTICS

3.1. SURFACE FEATURES

Surface features at the site consist of an inactive concrete Imhoff tank, A gravel leach field, and three former sewage evaporation lagoons. The site is located in the northeast portion of Igloo Area G (Figure 1-3). Unpaved ground surface surrounding the site is covered with gravel or grass.

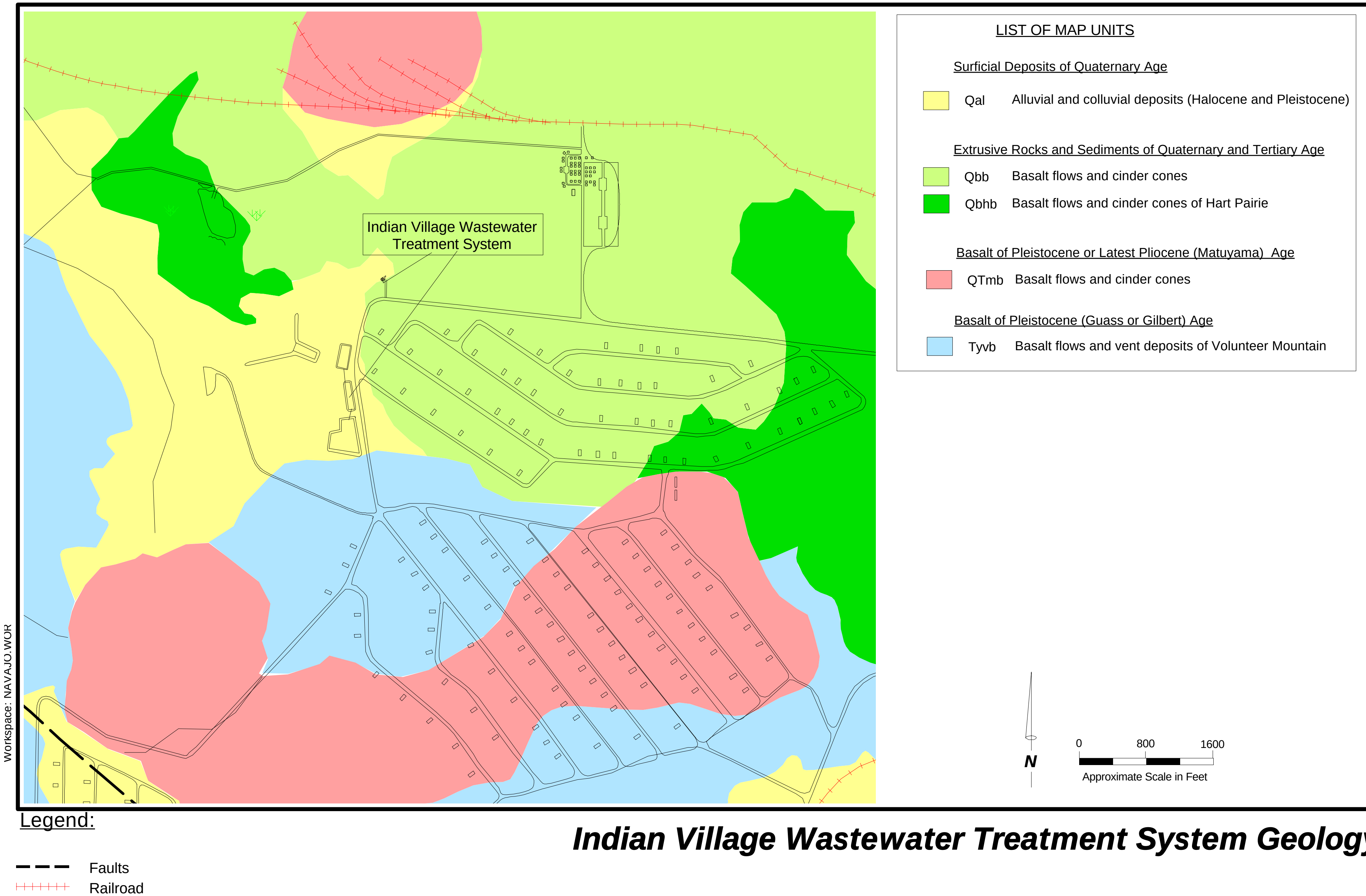
The topography in the area of the IVW is generally of low relief, and slopes to the south. The midsection of the site is approximately 20 feet below the uppermost surface area. Ground surface generally consists of gravel with less than 50 percent of sand.

3.2. GEOLOGY

Based on a review of geological maps, the shallow geology beneath the IVW appears to consist of Headquarters basalt overlying Hart Praire basalt overlying Volunteer Mountain basalts (Figure 3-1) (Tetra Tech 1999a). The Volunteer Mountain basalt is underlain by the Kaibab Formation. The three former sewage evaporation lagoons are underlain by a varying thickness of alluvium. This alluvium is underlain in the north by the same sequence of basalts as underlies the Imhoff tank. The alluvium in the south part of the site directly overlies Volunteer Mountain basalts. The edge of the quaternary basalts beneath the site is unkown. No subsurface investigations have been conducted in this area of the base; however, volcanic and extensive alluvium deposits do appear to be evident in the vicinity of IVW.

3.3. SOILS

The soils beneath the site have been classified by the Navajo Army Depot Soil Survey, Coconino County, Arizona, as Soil Unit 2, 7, 8 and 10 (USDA 1970). Soil Unit 2 soils are deep clay soils with a clay loam surface and zero to two percent slopes. Soil Unit 7 soils are moderately deep clay soils with a loam



Indian Village Wastewater Treatment System Geology

Camp Navajo, Bellemont, Arizona

Tetra Tech, Inc.

Figure 3-1

surface and zero to 15 percent slopes. Soil Unit 8 soils are moderately deep clay soils with a very stony loam surface and zero to eight percent slopes. Soil Unit 10 soils are moderately deep gravelly clay soils with a loam surface and have zero to five percent slopes.

The surface soil of Soil Unit 2 is generally a very dark grayish brown granular loam, having a pH of 6.5 and a thickness of one to six inches. The subsoil is generally a dark reddish brown clay with a blocky structure, having a pH of 7.5 and a thickness of 22 to 36 inches. This type of soil comprises approximately three percent of Navajo Army Depot soils, which accounts for approximately 900 acres of land on the base.

The surface soil of Soil Unit 7 is generally a brown platy granular gravelly loam, having a pH of 6.0 and a thickness of two to five inches. The subsoil is generally reddish brown blocky clay, having a pH of 7.5 and a thickness of 17 to 36 inches. This type of soil comprises approximately 11 percent of Navajo Army Depot soils, which accounts for approximately 3,050 acres of land on the base.

The surface soil of Soil Unit 8 is generally a brown very stony granular loam, having a pH of 6.5 and a thickness of two to six inches. The subsoil is generally reddish brown blocky clay, having a pH of 7.0 and a thickness of two to four inches. This type of soil comprises approximately 26 percent of Navajo Army Depot soils, which accounts for approximately 7,450 acres of land on the base.

The surface soil of Soil Unit 10 is generally a brown granular loam, having a pH of 7.0 and a thickness of three to five inches. The subsoil is generally a dark reddish gray gravelly clay with a blocky structure, having a pH of 7.8 and a thickness of 20 to 30 inches. This type of soil comprises approximately five percent of Navajo Army Depot soils, which accounts for approximately 1,400 acres of land on the base.

Physical testing of the soil sample collected during this investigation showed moisture was 6.8 percent. Dry density was 106.6 pounds per cubic foot (pcf). Grain size distributions was 18 percent gravel, 66 percent sand, and 16 percent fines. All physical analysis results are included in Appendix F.

3.4. HYDROGEOLOGY

Ground water occurrence in the vicinity of IVW is unknown; however, water-bearing zones may exist within the basalts beneath IVW. Shallow ground water flow in the vicinity of IVW is likely to be controlled by the topography on the underlying basalt and may not be the same as at the ground surface. The surface drainage from the site is to the east via an intermittent stream that flows eastward through Igloo Area G.

SECTION 4
NATURE AND EXTENT OF CONTAMINATION

The following section summarizes the nature and extent of contamination identified at IVW. All analytical results are tabulated by analysis method in Appendix E. Soil physical characteristics are in Appendix F. Appendix G includes copies of all laboratory reports for this site.

4.1. SEDIMENT SOILS

Concentrations of various metals are naturally occurring in soils. With the exception of mercury and selenium, no elevated concentrations of metals were identified in any of the sediment soil samples collected at this site (Table 4-1). A concentration of selenium was detected above background (0.8 mg/kg) in one sediment soil samples (at 3.6 mg/kg). A concentration of mercury was detected above background (0.3 mg/kg) in one sediment soil sample (at 0.52 mg/kg). All detected metals concentrations, except for arsenic and beryllium, were detected at concentrations less than the Arizona Department of Environmental Quality (ADEQ) nonresidential Health Based Guidance Levels (HBGLs). Arsenic and beryllium were found at concentrations higher than the ADEQ nonresidential HBGLs, but the concentrations are within background ranges previously defined for the installation (Tetra Tech 1997).

Background concentrations were established by statistical analysis of all samples collected at Camp Navajo. Outliers were identified during the analysis and were eliminated from the statistical test prior to determination of the background concentrations (Tetra Tech 1997).

A nitrogen compound was identified in all but one surface soil sample collected from the IVW (Table 4-2). The compound (nitrate plus nitrite as N) was identified at concentrations below ADEQ nonresidential HBGLs and thus is not considered to be a contaminant of concern.

Table 4-1
Indian Village Waste Water Treatment System Metal Results
(Detections Only)

Sample ID	Sample Date	Depth	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Lead, Total	Mercury, Total	Potassium, Total	Selenium, Total	Silver, Total
		CRQL	0.5	2	0.2	0.2	0.5	0.5	0.2	500	0.5	0.5
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
IVW-SD01S-01	11/4/95	1	6.8	524	1.8	0.6	57.2	25.1	0.52	2620	0.8	0.34 [J]
IVW-SD02S-01	11/4/95	1	9.4	495	1.8	< 0.1	50.1	12.9	< 0.033	1830	3.6	< 0.2
IVW-SD03S-01	11/4/95	1	4.2	422	1.4	< 0.05	62.2	14.4	0.084 [J]	2530	0.55 [J]	< 0.1
IVW-SS01S-01	11/4/95	1	2.3	69.4	0.34	0.3 [U]	10	19	0.13 [J]	731	< 0.3	0.3 [J]
IVW-SS02S-01	11/4/95	1	2.9	49.8	0.24	0.099 [U]	9	9.9	0.057 [J]	472 [J]	< 0.3	< 0.1
IVW-SS03S-01	11/4/95	1	1.7	55.1	0.25	0.076 [U]	9	9.6	0.061 [J]	463 [J]	< 0.3	< 0.1
IVW-SS04S-01	11/4/95	1	2.9	88.7	0.38	0.23 [U]	9.9	11.3	0.14 [J]	637	0.4 [J]	0.32 [J]
IVW-SS05S-01	11/4/95	1	3.3	89.1	0.5	0.26 [U]	14.2	14.3	0.14 [J]	919	0.41 [J]	0.45 [J]
Analyses			8	8	8	8	8	8	8	8	8	8
Detections			8	8	8	6	8	8	7	8	5	4
Maximum Concentration			9.4	524	1.8	0.6	62.2	25.1	0.52	2620	3.6	0.45
Arizona HBGL - Nonresidential			3.82	28700	1.34	244	5950	1400	123		2030	2030
Arizona HBGL - Nonresidential Hits			3	0	3	0	0	0	0		0	0
Maximum Background Concentration			44	1610	5	1.5	90	30	0.3	0	0.8	2.6
Background Hits			0	0	0	0	0	0	1	0	1	0

Notes:
CRQL contract required quantitation limits
< Less than the indicated detection limit
Data qualifiers are defined in Appendix E

Table 4-2
Indian Village Waste Water Treatment System Nitrogen Results
(Detections Only)

Sample ID	Sample Date	Depth	Nitrate plus Ni
		CRQL	0.5
		Units	mg/kg
IVW-SD01S-01	11/4/95	1	15.6
IVW-SD02S-01	11/4/95	1	5.1 U
IVW-SD03S-01	11/4/95	1	< 0.05
IVW-SS01S-01	11/4/95	1	30
IVW-SS02S-01	11/4/95	1	2.1 U
IVW-SS03S-01	11/4/95	1	1.8 U
IVW-SS04S-01	11/4/95	1	2.3 U
IVW-SS05S-01	11/4/95	1	1.9 U

Analyses	8
Detections	7
Maximum Concentration	30
Arizona HBGL - Nonresidential	665000
Arizona HBGL - Nonresidential Hits	0

Notes:
CRQL contract required quantitation limits
< Less than the indicated detection limit
Data qualifiers are defined in Appendix E

4.2. Surface Soils

Concentrations of various metals are naturally occurring in soils. No elevated concentrations of metals were identified in any of the surface soil samples collected at this site (Table 4-1).

Background concentrations were established by statistical analysis of all samples collected at Camp Navajo. Outliers were identified during the analysis and were eliminated from the statistical test prior to determination of the background concentrations (Tetra Tech 1997).

A nitrogen compound was identified in all the surface soil samples collected from the IVW (Table 4-2). The compound (nitrate plus nitrite as N) was identified at concentrations below ADEQ nonresidential HBGLs and thus is not considered to be a contaminant of concern.

4.3. Surface Water

With the exception of lead, no concentrations of metals were identified in the unfiltered surface water samples collected at this site above ADEQ HBGLs (Table 4-3). Concentrations of lead were detected in two water samples (up to 6.7 μg/L). Concentrations of lead were detected above both ADEQ drinking water HBGLs and Aquifer Water Quality Standards (AWQS).

Nitrogen compounds were identified in the surface water samples collected from the IVW (Table 4-4). The compound (nitrate plus nitrite as N) was identified at concentrations below ADEQ nonresidential HBGLs and thus is not considered to be a contaminant of concern. The low concentrations of nitrogen compounds indicate the absence of fresh sewage in the surface water.

4.4. Waste Characterization

With the exception of arsenic, beryllium, lead, and mercury, no concentrations of metals were identified in the unfiltered water samples collected at this site above ADEQ HBGLs (Table 4-3). A concentration of arsenic was detected in one water sample (at 4.6 μg/L). A concentration of beryllium was detected in one water sample (at 0.63 μg/L). Concentrations of lead were detected in two water sample (up to 81.2 μg/L). Concentrations of mercury were detected in two water samples(up to 3.3 μg/L). Concentrations of lead and mercury, were detected above both ADEQ drinking water HBGLs and AWQS.

Nitrogen compounds were identified in all water samples collected from the IVW (Table 4-4). The compound (nitrate plus nitrite as N) was identified at concentrations below ADEQ HBGLs and thus is not considered to be a contaminant of concern. The low concentrations of nitrogen compounds indicate the absence of fresh sewage in the sludge.

Table 4-3
Indian Village Waste Water Treatment System Metal Water Results
(Detections Only)

Sample ID	Sample Date	Depth	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Lead, Total	Mercury, Total	Potassium, Total	Selenium, Total	Silver, Total
		CRQL	5	20	2	2	5	5	0.5	5000	5	5
		Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
IVW-SW03W-01	11/2/95	0	< 3	229	< 0.5	< 0.5	4.4 U	3.2 U	< 0.2	2320 J	< 3	< 1
IVW-SW04W-01	11/2/95	0	< 3	8.7 J	< 0.5	< 0.5	1.7 U	6.7 U	< 0.2	2770 J	< 3	< 1
IVW-SW05W-01	11/2/95	0	< 3	8.9 J	< 0.5	< 0.5	1.7 U	6.1 U	< 0.2	2770 J	< 3	< 1
IVW-WC01W-01	11/4/95	0	< 3	67.2 J	< 0.5	< 0.5	1.5 J	29.4 J	0.81 J	3090 J	< 3	< 1
IVW-WC02W-01	11/4/95	0	4.6 J	252 J	0.63 J	0.64 J	17.3 J	81.2 J	2.1 J	4720 J	4.9 J	2.1 J
Analyses			5	5	5	5	5	5	5	5	5	5
Detections			1	5	1	1	5	5	2	5	1	1
Maximum Concentration			4.6	252	0.63	0.64	17.3	81.2	2.1	4720	4.9	2.1
Arizona HBGL			0.02	490	0.008	3.5	100	5	2.1		35	35
Arizona HBGL Hits			1	0	1	0	0	4	1		0	0
AWQS			50	2000	4	5	100	50	2		50	
AWQS Hits			0	0	0	0	0	1	1		0	

Notes:

CRQL	contract required quantitation limits
AWQS	Aquifer Water Quality Standard
<	Less than the indicated detection limit

Data qualifiers are defined in Appendix E

Table 4-4
Indian Village Waste Water Treatment System Nitrogen Water Results
(Detections Only)

Sample ID	Sample Date	Depth	Ammonia as N	Nitrate plus Nitrite as N
		CRQL	300	50
		Units	ug/L	ug/L
IVW-SW03W-01	11/2/95		110 J	28 U
IVW-SW04W-01	11/2/95		110 J	17 U
IVW-SW05W-01	11/2/95		< 70	35 U
IVW-WC01W-01	11/4/95		180 J	29 U
IVW-WC02W-01	11/4/95		120 J	280 U

Analyses	5	5
Detections	4	5
Maximum Concentration	180	280
Arizona HBGL		11000
Arizona HBGL Hits		0
AWQS		10000
AWQS Hits		0

Notes:
CRQL contract required quantitation limits
AWQS Aquifer Water Quality Standard
< Less than the indicated detection limit
Data qualifiers are defined in Appendix E

4.5. QA/QC

All samples were sent to Quanterra for inorganic parameter analyses. Temperature blanks for all coolers forwarded to the laboratory were within an acceptable range, and all coolers arrived with custody seals intact. Applicable holding times were met for all analyses. Three field duplicate samples, including three surface soil samples (SS) and three subsurface soil (HA) samples, were collected at the site during the investigation as shown below. Laboratory Data Consultants, Inc. (LDC), of Carlsbad, California, validated of the data.

- IVW-SS05S-01 blind duplicate of IVW-SS04S-01;
- IVW-WC02W-01 blind duplicate of IVW-WC01W-01; and,
- IVW-SW05W-01 blind duplicate of IVW-SW04W-01.

General validation findings applicable to all inorganic data resulted in the qualification of compound concentrations above the method detection limit but below the respective sample quantitation limit prior to dilution and percent moisture corrections. These reported values are considered to be qualitatively acceptable but quantitatively estimated due to uncertainties in analytical precision near the limit of detection. According to USEPA guidelines, however, these low concentration data are considered suitable for risk evaluation applications with appropriate recognition of the noted quantitative uncertainties.

Metals by USEPA Methods 6010A and 7471A

Evaluation of field duplicate results for the ten target elements indicated excellent qualitative and quantitative agreement between reported results for all media except the aqueous sludge. All relative percent differences (RPDs) were within quality control (QC) acceptance criteria with the exception barium, chromium, lead, and mercury in field duplicate samples IVW-WC01W-01and IVW-WC02W-01.

These incidents of imprecision may be attributable to heterogeneous contaminant distribution in aliquoted samples and to the matrix interferences characteristic of aqueous sludge medium. Although USEPA guidelines for inorganic data assessment do not require qualification of data on the basis of field duplicate precision alone, associated results for the indicated samples were flagged as quantitatively estimated in Appendix E. However, no restrictions on data usability for risk evaluation applications are expected.

Results of the validation by LDC noted trace metals contamination in several laboratory preparation blanks and affiliated equipment rinsate samples. Results for the following elements and field samples were indicated to be affected:

- Cadmium in all surface soil samples; and,
- Chromium and lead in all surface water samples.

Although the concentrations observed in the QC samples were less than half the respective sample quantitation limits, low-level metals results indicated above were qualified as nondetected in Appendix E and were considered to be usable for risk evaluation at adjusted reporting limits.

All other metals data for submitted field samples were determined to be valid without qualification and were considered usable for all purposes.

Inorganic Nitrogen Parameters by USEPA Methods 353.2 and 350.3

Evaluation of field duplicate results for inorganic nitrogen and ammonia analyses indicated general agreement between reported results. With the exception of nitrate/nitrite results for the aqueous sludge duplicate pair, IVW-WC01W-01 and IVW-WC02W-01, all RPDs were within QC acceptance criteria. However, the low level nitrate/nitrite results for these sludge samples were subsequently qualified as nondetected during validation, as described below. Consequently, ammonia and nitrate/nitrite field duplicate results for the site are considered acceptable and usable for remediation evaluation.

Validation findings reported nitrate/nitrite contamination in multiple equipment rinsate samples affiliated with project field samples. Therefore, nitrate/nitrite are considered to be a low concentration “field” or “system” contaminant impacting inorganic nitrogen data for samples of all media collected at the site. Although concentrations observed in the QC blanks were less than the respective sample quantitation limit, nitrate/nitrite results for the field samples indicated in Appendix E were qualified as nondetected and were considered to be usable for remediation evaluation at adjusted reporting limits.

All other inorganic nitrogen and ammonia data for submitted field samples were determined to be valid without qualification and were considered usable for all purposes.

4.6. INTERIM REMOVAL ACTIONS

Under contract with the USACE, Morrison Knudsen Corporation (MK) was tasked to remove the water and sludge inside the Imoff tank (MK 1996) (Appendix H).

On October 1996, approximately 21,300 gallons of water were pumped from the tank and disposed of. Approximately 30 cubic yards of contaminated sludge, wood, and roofing material remained in the tank. Due to the amount of material in the tank, the Arizona National Guard directed MK to cease operations at this location until additional funds for the work could be obtained.

SECTION 5
CONTAMINANT FATE AND TRANSPORT

Section 4 discussed the potential contaminants of concern for the IVW site soils and surface water. Selenium was the only metal detected above the maximum background level in site soils. Arsenic and beryllium concentrations in soils exceeded industrial HBGLs on three occasions but did not exceed base-wide background concentrations. Surface water samples contained concentrations of arsenic, beryllium, lead, and mercury above the drinking water HBGLs. This section provides a summary of the potential routes of migration, ability to persist in the environment, and relative migration potential for these contaminants of concern.

5.1. POTENTIAL ROUTES OF MIGRATION

The same potential routes of migration exist for organic and inorganic compounds in soils. The contaminants can become dissolved in infiltrating precipitation and transported vertically downward. This process can be quite rapid where near-vertical open channels, such as solution planes or fractures, exist. Overland routes of migration include transport by wind as particulates or excavation and transport by humans or animals.

5.2. CONTAMINANT PERSISTENCE

As elements, the observed metals at the site cannot be further degraded. In subsurface environments, elemental metals often form silicate, carbonate, and sulfate precipitates.

5.3. CONTAMINANT MIGRATION

The rate of migration of metals in saturated and unsaturated soils is strongly influenced by adsorption processes, particularly where cationic metals are sorbed onto soil particle imperfections with negative electrical charges. The cation exchange capacity (CEC) represents the total number of negatively charged sites in a given amount of solid at which adsorption and desorption can occur. Clays, such as those present at the IVW site, commonly have high CECs. It is expected that adsorption will severely retard the movement of metals contaminants. In addition, in the pH ranges common to ground water flow systems, transport of metals in ground water is limited by their low solubilities.

SECTION 6
RISK SCREENING

Current activities and activity patterns at the site are considered commercial/industrial, as are the documented land uses surrounding the site. Therefore, for purposes of this risk screening, land use of the site is assumed to be industrial. Previous operations at the site have indicated inorganic nitrogen and metals compounds to be the principal chemicals of concern (COCs) posing a potential exposure risk to workers involved in commercial/industrial activities on-site.

Based on maximum reported sediment concentrations, the only metals with detectable levels greater than the corresponding HBGLs developed by the Arizona Department of Health Services (ADHS), using nonresidential exposure assumptions, were arsenic and beryllium. Surface soil (gravel leach field samples) concentrations of all elements analyzed for were below respective ADHS HBGLs. Potassium was eliminated from the risk screening based on its relative low toxicity and because its maximum reported concentration in both sediments and surface soils was less than the USEPA ceiling limit of $1x10^{+5}$ mg/kg reserved for less toxic inorganic contaminants.

For sediment samples, the maximum concentrations for arsenic (9.4 mg/kg) and beryllium (1.8 mg/kg) samples were observed to exceed current ADHS HBGLs for nonresidential soils (3.82 mg/kg and 1.34 mg/kg, respectively) as well as current USEPA Region IX preliminary remediation goals (PRGs) for industrial soils (2.4 mg/kg and 1.1 mg/kg, respectively). However, from a quantitative risk screening perspective using USEPA total risk criteria, reported sediment concentrations for arsenic and beryllium are considered to reside within an acceptable range of both health-based standards under expected exposure conditions.

Furthermore, maximum sediment and surface soil concentrations of arsenic and beryllium were below naturally occurring background levels recorded for the geographical area encompassing the Camp Navajo base. Background concentration levels of 44 mg/kg for arsenic and 5.0 mg/kg for beryllium (Tetra Tech 1997) indicate that the reported sediment and surface soil results are consistent with naturally occurring conditions. According to both USEPA and USACE guidelines, if inorganic chemicals are detected at the site at naturally occurring concentrations, they may be eliminated from the corresponding risk evaluation.

Arsenic, beryllium, lead, and mercury were likewise reported in aqueous sludge samples at concentrations significantly above the respective HBGLs established by ADHS. In addition, lead was detected in surface water samples at concentrations above the respective HBGL. However, because commercial/industrial activities at the site do not interface with media contained in the Imoff tank, elevated concentrations of metals detected in the water and sludge are not expected to pose a potential health risk to occupational workers under anticipated conditions of exposure.

Finally, concerns over potential migration of these elements from water in the Imoff tank to the deep regional aquifer are minimized since the detected metals were all identified in unfiltered samples. This may indicate that the metals are suspended or colloidal, rather than dissolved, in surface water and aqueous sludge samples. Additionally, the low water solubility of the noted metals and their relative tendency to sorb with particulates under aqueous conditions strongly indicates that the fraction of these metals likely to leach from aqueous surface media at the site to the deep regional ground water would be toxicologically insignificant. In addition, the elevated concentrations were all associated with water and sludge within the Imoff tank. Visual inspection of the Imoff tank suggests that it is in good condition and is unlikely to be leaching to the surrounding soils.

6.1. RISK ASSESSMENT SUMMARY

A group-wide risk assessment for Group B-4 including a quantitative evaluation of the IVW, was prepared in June 1999 (Tetra Tech 1999b). The results of the risk assessment concurred with the risk screening above. No excess carcinogenic risks ($>10^{-6}$) were identified in relation to surface soils or near surface soils. No evaluated noncarcinogenic hazard indices (>1) were identified in relation to surface soils or near surface soils. There is no primary contributor to carcinogenic risks and noncarcinogenic hazard indices in surface and near-surface soils. The ecological risk action level for a selected wildlife indicator species was not exceeded.

SECTION 7
SUMMARY AND CONCLUSIONS

7.1. SUMMARY

Twelve inorganic compounds were detected in sediments, surface soils, and surface water at the former indian village waste water treatment system. Most of the compounds were detected below their appropriate HBGLs or established background concentrations.

No contaminants of concern were identified in surface soils of sediment at the site. No contaminants of concern were identified in surface water from the treatment lagoons.

The only contaminant of concern identified in surface water within the Imoff tank is lead (6.7 μg/L). Contaminants of concern in sludge at the bottom of the Imoff tank include arsenic (up to 4.6 μg/L), beryllium (up to 0.63 μg/L), lead (up to 81.2 μg/L), and mercury (up to 21 μg/L). Arsenic and beryllium are likely related to high ambient concentrations in soils at Camp Navajo

7.2. CONCLUSIONS

Risk evaluation results indicate that the maximum reported concentrations of identified contaminants in surface soils, sediments, and surface water at the site would not be expected to result in adverse health effects relevant to commercial/industrial land use.

Because current activities at the site do not interface with environmental media contained in the Imoff tank, contaminants reported in the surface water and aqueous sludges in the tank are likewise not expected to pose a potential health risk to occupational workers under anticipated exposure conditions. However, because many of the detected metals are classified as potential carcinogens and usually are subject to quantitative risk assessment when detected at elevated levels, general efforts should be taken to reduce the potential for and duration of any occupational exposure. Workers performing commercial/industrial activities on-site and who come into contact with surface media should wear dermal and inhalation protection appropriate to the task. These determinations incorporate the most current ADHS, USEPA and USACE acceptable target risk criteria into their approach and are intended to be a health-conservative evaluation of potential risk and hazard.

All data collected during this investigation meet QA/QC standards and are considered to represent site conditions. Therefore, based on the lack of detected contamination exceeding either HBGLs or risk screening, Tetra Tech recommends the site for consideration for closure by ADEQ.

SECTION 8
REFERENCES

Arizona Department of Health Services (ADHS). 1997. *Arizona Soil Remediation Levels*. Prepared for the Arizona Department of Environmental Quality in accordance with A.R.S. §§ 49-151 and A.R.S. §§ 49-152.

EBASCO Environmental (EBASCO). 1990. *Enhanced Preliminary Assessment Report: Navajo Army Depot Activity, Bellemont, Arizona*. March 1990.

Tetra Tech, Inc. (Tetra Tech). 1997. *Final Technical Memorandum Background Metals for Camp Navajo, Bellemont, Arizona*. Tetra Tech, Inc. San Francisco, California. August 1997

_______. 1999a. *Final Ground Water Investigation Camp Navajo, Bellemont, Arizona*. Tetra Tech, Inc. San Francisco, California. June 1999.

_______. 1999b. *Final Risk Assessment, Group B-1, Camp Navajo, Bellemont, Arizona*. Tetra Tech, Inc. San Francisco, California. June 1999.

Uribe and Associates (Uribe). 1993. *Visual Site Inspection Report, Camp Navajo. Contract 68-W2-0016/9-92-1-1077*. Submitted to Environmental Protection Agency, Region IX, San Francisco, California. November 1993.

US Army Corps of Engineers (USACE). 1995. *Risk Assessment Handbook: Volume: I Human Health Assessment (EM200-1-4)*. June 30, 1995.

US Army Environmental Hygiene Agency (USAEHA). 1987. *Ground Water Contamination Survey, No. 38-26-0878-88, Evaluation of Solid Waste Management Units, Navajo Army Depot, Bellemont, Arizona.*

US Department of Agriculture (USDA). 1970. *Soil Survey of Navajo Army Depot, Coconino County, Arizona: A Special Report*. January 1970.

US Environmental Protection Agency (USEPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*.

_______. 1989. *Risk Assessment Guidance (RAGS) for Superfund: Volume: I Human Health Evaluation Manual (PB90-155581)*. December 1989.

_______. 1992. *Guidance for Data Useability: Parts A and B Final Report (PB92-963356)*. April 1992.

_______. 1996. *Preliminary Remediation Goals (PRGs).* Region IX. August 1996.

APPENDIX A

PHOTO DOCUMENTATION

2-23 Entrance to IMHOFF Tank Area, N, 7/20/94, by Brad Hall

2-24 IMHOFF Sludge Pond, NW, 7/20/94, by Brad Hall

2-25 IMHOFF Tank, SW, 7/20/94, by Brad Hall

3-1 IMHOFF Tank & Lines, NE, 7/20/94, by Brad Hall

15-5 Panorama (with R15P06) east bank of south-most lagoon - Indian Village Wastewater Lagoons, SW, 10/28/94, by Tom Whitehead

15-6 Panorama (with R15P05) west half of lagoon - Indian Village Wastewater Lagoons, SW, 10/28/94, by Tom Whitehead

15-7 Drain pipe (?) at south end of middle lagoon connecting wastewater lagoons - Indian Village Wastewater Lagoons, NE, 10/28/94, by Tom Whitehead

15-8 Shallow ditch at south end of north-most lagoons - Indian Village Wastewater Lagoons, NE, 10/28/94, by Tom Whitehead

15-9 Detail of interior surface northwest lagoon - Indian Village Wastewater Lagoons, NE, 10/28/94, by Tom Whitehead

39-7 Clay Nelson surface soil sampling at Indian Village Wastewater at SS 04 (moved while shooting), NW, 11/3/95, by Kevin Joyce

39-8 Clay Nelson surface sampling at Indian Village Wastewater at SS 04, NW, 11/3/95, by Kevin Joyce


OCT 95


OC1 95

APPENDIX B

FIELD NOTES

APPENDIX C

STANDARD OPERATING PROCEDURES

SECTION 1
SURFACE-SOIL SAMPLING

1.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the considerations and procedures for collecting representative surface samples. Analysis of surface samples can determine whether concentrations of specific surface pollutants exceed established action levels, and if the concentrations of soil pollutants present a risk to public health, welfare, or the environment.

Materials exposed on the land surface, including soils, sediments, and wastes, are subject to disturbance by weather conditions, vehicle traffic, bioturbation, and other effects. Because volatile contaminants are unlikely to be present in surficial materials, it generally is not necessary to obtain undisturbed samples from the surface. An exception to is when surface samples are collected from beneath an impermeable surface, such as a road or building slab. Surface soils are typically very heterogeneous in compositions and texture, and chemical concentrations in surface soils may vary dramatically over short depth intervals. Often, the first few inches of soil contain gravel, vegetation, or debris. It is desirable to use a sampling method that reduces the impacts of these heterogeneities without biasing the results.

For surface-soil sampling, some judgment may be needed to identify the ground surface datum. The objective is to sample the soil matrix and avoid collecting rock and plant material to the extent possible. Vegetation will be moved aside, dense vegetative matting, detritus or roots will be removed, and gravel will be scraped away to expose the ground surface. Surface samples from beneath pavement or concrete slabs will be collected after first removing road base and gravel to expose the underlying soil. In some locations, such as in the basements of buildings, the ground surface will be below grade. In these cases, depth below grade will be measured and recorded.

1.2 TECHNIQUE - DESCRIPTION

Soil samples may be collected using a variety of methods and equipment. The methods and equipment used are dependent on the type of sample required (disturbed versus undisturbed) and the type of soil. Samples that do not need to be undisturbed may be easily sampled using a spade, trowel, or scoop. Collecting undisturbed samples may be performed using a hand-auger, a trier, or a split-spoon sampler.

1.3 PROCEDURES

1.3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are required.

2. Obtain necessary sampling and air monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare schedules, and coordinate with staff, client, and regulatory agencies as appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.

6. Use stakes, buoys, or flagging to identify and mark all sampling locations. Consider specific site factors, including extent and nature of contaminant, when selecting sample location. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. All staked locations will be cleared for underground utilities by the property owner prior to soil sampling.

1.3.2 Interferences and Potential Problems

There are two primary interferences or potential problems associated with soil sampling. These are cross-contamination of samples and improper sample collection methods. Cross-contamination can be eliminated or minimized through the use of sampling equipment dedicated to each sample location. If this is not possible or practical, then decontamination of sampling equipment is necessary. Improper sample collection methods include using contaminated sampling equipment, disturbing of the matrix causing in compaction of the sample, or inadequate homogenizing of the samples where required, which results in variable, non-representative analytical results.

1.3.3 Sampling Considerations

This method can be used in most soil types. Surface soil samples may be collected with spades, shovels, or scoops. Surface material can be removed to the required depth with this equipment, then a stainless steel or plastic scoop can be used to collect the sample.

Accurate, representative samples can be collected with this procedure depending on the care and precision taken. A flat, pointed mason trowel can be used to cut a block of the desired soil when undisturbed profiles are required. A stainless steel scoop, lab spoon, or plastic spoon will suffice in most other cases. Avoid the use of devices plated with chrome or other materials. Plating is particularly common with garden implements such as potting trowels.

Follow these procedures to collect surface-soil samples.

1. Carefully remove the top layer of soil or debris to the desired sample depth with a pre-cleaned spade.

2. Using a pre-cleaned, stainless-steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area which came in contact with the spade.

3. If the sample is to be analyzed for volatile organics, volatile organic analysis is to be performed, transfer a portion of the sample directly into an appropriate, labeled sample container(s) with a stainless-steel lab spoon, plastic lab spoon, or equivalent and secure the cap(s) tightly. Place the remainder of the sample into a stainless steel, plastic, or other appropriate homogenization container, and mix thoroughly to obtain a homogeneous sample representative of the entire sampling interval. Then, place the sample into an appropriate, labeled container(s) and secure the cap(s) tightly.

1.3.4 Sample Containers and Preservation Techniques

In order to ensure proper sample preservation, samples should be refrigerated to 9°C or less and holding time should be kept to a minimum.

1.3.5 Field Quality Control Sampling Procedures

There are no specific quality-assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

- All data must be documented on field data sheets or within site logbooks.

- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior and after sampling/operation and they must be documented.

1.3.6 Decontamination Procedures

All sample equipment that comes into contact with soil or water must be decontaminated prior to sampling. Decontamination procedures for sampling equipment are described in the Decontamination of Field Equipment SOP.

SECTION 2
WASTE CHARACTERIZATION SAMPLING

2.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the considerations and procedures and to establish the guidelines for the waste characterization sampling. Waste characterization sampling will be performed to identify hazardous characteristics of unknown materials.

2.2 TECHNIQUE - DESCRIPTION

Drums and Containers

Samples of waste solids exposed at the ground surface will be sampled as for surface soil sampling, as described in the Surface Soil Sampling SOP. Specialized sampling methods will be used if the waste is in liquid form or is present in drums or other containers.

Prior to sampling, drums and containers must be inventoried, staged, and opened. An inventory entails recording visual qualities of each drum or containers and any characteristics pertinent to the contents' classification. Staging involves the organization, and sometimes consolidation of drums and containers which have similar wastes or characteristics. Opening of closed drums can be performed manually or remotely. Remote drum opening is recommended for worker safety. The most widely used method of sampling a drum involves the use of a glass thief. This method is quick, simple, relatively inexpensive, and requires no decontamination.

2.3 PROCEDURES

2.3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the equipment and supplies that will be needed.

2. Obtain necessary sampling and monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.

6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

2.3.2 Drum Inspection

Appropriate procedures for handling drums depend on the contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. Those in charge of inspections should be on the look-out for:

- drum condition, corrosion, rust, and leaking contents;
- Symbols, words, or other markings on the drum indicating hazards (i.e., explosive, radioactive, toxic, flammable);
- Signs, such as bulging drum ends, that the drum is under pressure; and
- Shock sensitivity.

Monitor around the drums with radiation instruments, organic vapor monitors (OVAs), and combustible gas indicators (CGIs).

Classify the drums into categories, for instance:

- Radioactive;
- Leaking/deteriorating;
- Bulging;
- Drums containing lab packs; and
- Explosive/shock sensitive.

All personnel should assume that unmarked drums contain hazardous materials until their contents have been categorized, and that labels on drums may not accurately describe their contents.

If it is presumed that there are buried drums on-site, geophysical investigation techniques such as magnetometry, ground penetrating radar, and metal detection can be employed in an attempt to determine depth and location of the drums.

2.3.3 Drum Staging

Prior to sampling, the drums should be staged to allow easy access. Ideally, the staging area should be located just far enough from the drum opening area to prevent a chain reaction if one drum should explode or catch fire when opened.

While staging, physically separate the drums into the following categories: those containing liquids, those containing solids, lab packs, or gas cylinders, and those which are empty. This is done because the strategy for sampling and handling drums/containers in each of these categories will be different. Drum categorization may be achieved by:

- Visual inspection of the drum and its labels, codes, etc. Solids and sludges are typically disposed of in open-top drums. Closed-head drums with a bung opening generally contain liquid.

- Visual inspection of the contents of the drum during sampling, followed by restaging if needed.

Once a drum has been evaluated and any immediate hazard has been eliminated by over-packing or transferring the drum's contents, affix a numbered tag to the drum and transfer it to a staging area. Color-coded tags, labels, or bands should be used to mark similar waste types. Record on a drum data sheet a description of each drum, its condition, any unusual markings, and the location where it was buried or stored. This data sheet becomes the principal record keeping tool for tracking the drum on site.

Drums that may contain radioactive, explosive, or shock-sensitive materials, these drums should be staged in a separate, isolated area. Placement of explosives and shock-sensitive materials in diked and fenced areas will minimize the hazard and the adverse effects of any premature detonation of such materials.

Where space allows, the drum opening area should be physically separated from the drum removal and drum staging operations. Drums are moved from the staging area to the drum opening area one at a time using forklift trucks equipped with drum grabbers or a barrel grappler. In a large-scale drum handling operation, drums may be conveyed to the drum opening area using a roller conveyor.

2.3.4 Drum Opening

There are three basic techniques available for opening drums at hazardous waste sites:

- Manual opening with non-sparking bung wrenches;

- Drum deheading; and

- Remote drum puncturing or bung removal.

The choice of drum opening techniques and accessories depends on the number of drums to be opened, their waste contents, and their physical condition. Remote drum opening equipment should always be considered to protect worker safety. Under OSHA 1910.120, drums should be opened with bung wrenches or deheaders only if the drum is structurally sound and its contents are known to be (1) not shock sensitive, (2) non-reactive, (3) non-explosive, and (4) non-flammable.

Manual Drum Opening with a Non-Sparking Bung Wrench

Manual drum opening with non-sparking bung wrenches should not be performed unless the drums are structurally sound (no evidence of bulging or deformation) and their contents are known to be non-explosive. If opening the drum with bung wrenches is deemed reasonably cost-effective and safe, then follow these procedures to minimize the hazard:

1. Fully outfit field personnel with protective gear.

2. Position drum upright with the bung up, or, for drums with bungs on the side, lay the drum on its side with the bung plug up.

3. Wrench the bung with a slow, steady pulling motion across the drum. If the length of the bung wrench handle provides inadequate leverage for unscrewing the plug, attach a "cheater bar" to the handle to improve leverage.

Manual Drum Opening with a Drum Deheader

Drums are opened with a drum deheader by first positioning the cutting edge just underneath the top lip and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will cut off the entire top. If the top chime of a drum has been damaged or badly dented, it may not be possible to cut off the entire top. Since there is always the possibility that a drum may be under pressure, make the initial cut very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to use a remote method to puncture the drum prior to using the deheader.

Self-propelled drum openers which are either electrically or pneumatically driven can be used for quicker and more efficient deheading.

Manual Drum Opening with a Hand Pick, Pickaxe, or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, the drum can be opened for sampling by using a hand pick, pickaxe, or spike. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. The potential for splash or spraying is greater than with other opening methods and, therefore, this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums cannot be opened slowly with these tools, spray from drums is common, and requires appropriate safety measures. Decontaminate the pick or spike after each drum is opened to avoid cross-contamination and/or adverse chemical reaction from incompatible materials.

2.3.5 Remote Methods

Remotely operated drum opening tools are the safest available means of drum opening. Remote drum opening is slow, but is much safer compared to manual methods of opening.

Remote Drum Opening with a Backhoe Spike

Prior to opening, drums should be "staged" or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross-contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the required level of personal protective gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board air line system.

Remote Drum Opening with Hydraulic Devices

Drums can be opened using a piercing device with a metal point that is attached to the end of a hydraulic line and then is pushed into the drum by hydraulic pressure. The piercing device can be attached so that the sampling hole can be made on either the side or the head of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place if desired and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

Remote Drum Opening with Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely.

2.3.6 Drum Sampling

After the drum has been opened, test the headspace gases using an explosimeter and an organic vapor analyzer before sampling.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample of the liquid should be representative of the entire depth of the vessel.

When sampling a previously sealed vessel, check for the presence of a bottom sludge. This is easily accomplished by measuring the depth to the apparent bottom, then comparing it to the known interior depth.

Glass Thief Sampler

The most widely used implement for sampling is a glass tube commonly referred to a glass thief. This tool is simple, cost effective, quick, and, because the thief is disposable, decontamination is not required. Glass thieves are typically four feet long and 6mm to 16mm in diameter.

Procedures for using a glass thief are as follows:

1. Remove cover from sample container.

2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About one foot of tubing should extend above the drum.

3. Allow the waste in the drum to reach its natural level in the tube.

4. Cap the top of the sampling tube with a thumb or tapered stopper, ensuring liquid does not come into contact with the thumb or stopper.

5. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container.

6. Release stopper and allow the glass thief to drain until the container is full.

7. Remove tube from the sample container, break the tube into pieces, and place the pieces in the drum.

8. Cap the sample container tightly and place prelabeled sample container in a carrier.

9. Replace the bung or place plastic over the drum.

10. Log all samples in the site logbook and on field data sheets.

11. Package samples and complete necessary paperwork.

12. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

In many instances a drum containing waste material will have a sludge layer on the bottom. Slow insertion of the sample tube down into this layer and then a gradual withdrawal will allow the sludge to act as a bottom plug to maintain the fluid in the tube. The plug can be gently removed and placed into the sample container by the use of a stainless steel lab spoon.

It should be noted that in some instances disposal of the tube by breaking it into the drum may interfere with eventual plans for the removal of its contents. This practice should be cleared with the project officer or other disposal techniques evaluated.

COLIWASA Sampler

Some equipment is designed to collect a sample from the full depth of a drum and maintain it in the transfer tube until delivery to the sample bottle. These designs include primarily the Composite Liquid Waste Sampler (COLIWASA) and modifications thereof. The COLIWASA is a much cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. One configuration consists of a 152 cm by 4 cm I.D. section of tubing with a neoprene stopper at one end attached to a locking mechanism at the other end by a rod running the length of the tube.

Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper.

The major drawbacks associated with using a COLIWASA are decontamination and cost. The sampler is difficult, if not impossible to decontaminate in the field and its high cost makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Follow these procedures for using the COLIWASA:

1. Open sampler by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

2. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

3. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

4. Slowly withdraw the sample from the waste container with one hand while wiping the sampler tube with a disposable cloth or rag with the other hand.

5. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

6. Cap the sample container tightly and place prelabeled sample container in carrier.

7. Replace the bung or place plastic over the drum.

8. Log all samples in the site logbook and on field data sheets.

9. Package samples and complete necessary paperwork.

10. Transport sample to decontamination zone to prepare it for transport to the analytical laboratory.

11. Until the identification of the liquid waste is determined, store the used COLIWASA and cloth or rag that was used in wiping the sampler tube in the established decontamination zone.

2.3.7 Interferences and Potential Problems

The practice of tapping on drums to evaluate the state or amount of their contents is neither safe nor effective and should not be used if the drums are visually over-pressurized or if shock-sensitive materials are suspected.

Drums that have been over-pressurized to the extent that the head is swollen several inches beyond the chime should not be moved. A number of devices have been developed for venting critically swollen drums. One method that has been proven to be effective is a tube and spear device. A light aluminum tube (3 meters long) is positioned at the vapor space of the drum. A rigid hooking device attached to the tube goes over the chime and holds the tube securely in place. The spear is inserted in the tube and positioned against the drum. A sharp blow on the end of the spear drives the sharpened tip into the drum and the gas vents along the grooves. The venting should be done from behind a wall or barricade. This device can be cheaply and easily designed and constructed where needed. Once the pressure has been relieved, the bung can be removed and the drum sampled.

2.3.8 Sample Containers and Preservation Techniques

Samples collected from drums are considered waste samples. No preservatives should be added since there is a potential reaction of the sample with the preservative. Samples should, however, be cooled to 4°C and protected from sunlight in order to minimize any potential reaction resulting from light sensitivity of the sample.

Sample bottles for collection of waste liquids, sludges, or solids are typically wide-mouth amber jars with Teflon-lined screw caps. The volume required for analysis should be determined by consulting with the laboratory performing the analysis.

1. Place the filled and labeled sample container in two tested Ziploc plastic bags and seal the bags.

2. Place each bagged container in a 1-gallon covered metal can containing absorbent packing material. Place the lid on the can.

3. Mark the sample identification number on the outside of the can.

4. Place the marked cans in a cooler, and fill remaining space in the cooler with absorbent packing material.

5. Fill out chain of custody form for each cooler, place in a sealable plastic bag, and affix to inside lid of cooler.

6. Secure the lid of cooler and seal the lid with one or more and custody seals.

Arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

2.3.9 Field Quality Control Sampling Procedures

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

- All data must be documented on field data sheets or within site logbooks.

- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior and after sampling/operation and they must be documented.

2.3.10 Decontamination Procedures

All sample equipment that comes into contact with soil and/or water must be decontaminated prior to sampling. Decontamination procedures for sampling equipment are described in the Decontamination of Field Equipment SOP.

SECTION 3
SURFACE WATER SAMPLING

3.1 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the considerations and procedures, and to establish the guidelines for the collection of representative liquid samples, both aqueous and non aqueous, from streams, rivers, lakes, ponds, lagoons, and surface impoundments. The SOP includes samples from depth, as well as collecting surface samples. The rationales for collecting surface water samples are discussed in the site-specific sampling plans.

3.2 TECHNIQUE - DESCRIPTION

Sampling situations vary widely and therefore no universal sampling procedure can be recommended.

However, sampling of both aqueous and non-aqueous liquids from the above-mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- Kemmerer bottle
- bacon bomb sampler
- dip sampler
- direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.2.1 Method for Sampling Surface Water

In large ponds or where nonuniform conditions are suspected, water from multiple depths or locations will be tested in the field to identify sampling locations representative of the range of conditions present. Sampling locations will be located relative to permanent site features by triangulation.

In most locations with relatively small water bodies, the liquid to be collected will be well-mixed. Samples will be collected by removing the cap from a clean sample bottle while holding the bottle at least six inches below the water surface.

3.3 PROCEDURES

3.3.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and which equipment and supplies are needed.

2. Obtain necessary sampling and water monitoring equipment.

3. Decontaminate or preclean equipment, and ensure that it is in working order.

4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.

5. Perform a general site survey prior to site entry in accordance with the site-specific health and safety plan.

6. Use stakes, flags, or buoys to identify and mark all sampling locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

3.3.2 Interferences and Potential Problems

The two main interferences or potential problems with surface water sampling are cross-contamination of samples and improper sample collection.

- Cross-contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Decontamination of Field Equipment SOP.

- Improper sample collection includes using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

3.3.3 Sampling Considerations

Representative Samples

In order to collect a representative sample, the hydrology and morphometrics (e.g., measurements of volume, depth, etc.) of stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at 1-meter intervals from the substrate to the surface using an appropriate instrument, such as a Hydrolab (or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxygen-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths anytime surface water samples are collected.

Selection of Sampling Device

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

- Whether the sample be collected from the shore or from a boat on the impoundment;
- The desired depth at which the sample is to be collected; and
- The overall depth and flow direction of river or stream.

Filtration

The purpose of filtration is to remove solids from samples where analysis of only dissolved phases is desired. preservation of For samples in which the filter will not interact with their dissolved constituents, filtration is performed prior to preservation of the samples. Samples typically are filtered prior to preservation and analysis for dissolved metals, so the acid preservation will not dissolve metal-containing solid-phases.

In general, the laboratory will be requested to perform the sample filtration. Unfiltered samples submitted to the laboratory will not be preserved in the field. The laboratory analytical request portion of the chain-of-custody form will be filled out to indicate that the sample is unfiltered and unpreserved.

If filtration is performed in the field, the sample will be filtered through a 0.45 micrometer membrane filter cartridge. Each sample to be filtered will be first placed in a new polycarbonate sample bottle without preservatives and then pumped with a peristaltic through the filter cartridge into a second new polycarbonate sample bottle containing preservative. New tubing will be placed in the peristaltic pump for each sample. If a pump is being used to sample the well, the sample will be drawn from a sampling port on the pump line, through a 0.45 micron filter, directly into the preserved sample container.

Sampler Composition

The proper sampling device must be of a composition that will not interact with or adsorb the compounds that will be analyzed. Samplers constructed of glass, stainless steel, PVC, or PFTE (Teflon) may be used as appropriate.

3.3.4 Sample Containers and Preservation Techniques

Kemmerer Bottle

A Kemmerer bottle may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Using a properly decontaminated Kemmerer bottle, set the sampling device so that the sampling end pieces are pulled away from the sampling tube, allowing the substance to be sampled to pass through the tube.

2. Lower the pre-set Kemmerer bottle to the predetermined depth. Avoid bottom disturbance.

3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.

4. Retrieve the sampler and discharge the first 10 to 20 ml to clear any potential contamination on the valve. Transfer the sample to the appropriate sample container.

Bacon Bomb Sampler

A bacon bomb sampler may be used in similar situations to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut.

2. Close the sampler by releasing the trigger line and retrieve the sampler.

3. Transfer the sample to the appropriate sample container by pulling the trigger.

Dip Sampler

A dip sampler is useful for situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the dip sampler in accordance with the manufacturer's instructions.

2. Extend the sampler to the sample location and collect the sample.

3. Retrieve the sampler and transfer the sample to the appropriate sample container.

Direct Method

For streams, rivers, lakes, and other surface waters, water samples may be collected directly from the surface. Direct sampling is not to be used for sampling lagoons or other impoundments where contact with contaminants are a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample, using the sample container, under the water surface pointing the sample container upstream. The container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles for collecting the sample because the collection method may dilute the concentration of preservative necessary for proper sample preservation. When pre-preserved sample bottles are necessary, collect the sample in an non-preserved sample bottle and then transfer the sample into the appropriate pre-preserved bottle.

Once samples have been collected, follow these procedures:

1. Transfer the sample(s) into suitable labeled sample containers.

2. Preserve the sample if appropriate, or use preserved sample bottles.

3. Cap the container, put it in a Ziploc plastic bag, and place it on ice in a cooler.

4. Record all pertinent data in the site logbook and on a field data sheet.

5. Complete the chain-of-custody form.

6. Attach custody seals to the cooler prior to shipment.

7. Decontaminate all sampling equipment prior to the collection of additional samples.

3.3.5 Field Quality Control Sampling Procedures

There are no specific quality assurance activities which apply to the implementation of these procedures. However, the following general QA/QC procedures apply:

- All data must be documented on field data sheets or within site logbooks.

- All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan.

Equipment must be checked out and calibrated prior and after sampling/operation and the check out and calibration must be documented.

3.3.6 Decontamination Procedures

All sample equipment that comes into contact with soil and/or water must be decontaminated prior to sampling. Decontamination procedures for sampling equipment are described in the Decontamination of Field Equipment SOP.

APPENDIX D

SURVEYOR RESULTS

Survey

siteid	PTID	Northing	Easting	Elevation
IVW	SD01	29987.83	8312.97	
IVW	SD02	29570.41	8312.76	
IVW	SD03	29127.66	8317.02	
IVW	SS01	30757.42	8741.53	
IVW	SS02	30752.89	8758.31	
IVW	SS03	30743.65	8745.28	
IVW	SS04	30747.98	8726.5	
IVW	SW01	29753.52	8213.21	
IVW	SW02	29251.69	8342.41	
IVW	SW03	28789.6	8290.92	
IVW	WC01	30804.15	8733.58	
IVW	WC02	21548.72	28287.73	

APPENDIX E

ANALYTICAL RESULTS TABLES

Description of Qualifiers

J	Data are considered quantitatively estimated.
J+	Data are considered quantitatively estimated with a possible high bias.
J-	Data are considered quantitatively estimated with a possible low bias.
N	Data are considered quantitatively presumptive due to tentative analyte identification.
NJ	Data are considered quantitatively presumptive due to tentative analyte identification; the associated value is considered quantitatively estimated.
R	Data are rejected and considered unusable for all purposes.
U	Analyte is considered not present above the level of the associated value.
UJ	Analyte is considered not present above the level of the associated value; the associated value is considered quantitatively estimated.
UJ-	Analyte is considered not present above the level of the associated value; the associated value is considered quantitatively estimated with a possible low bias.

Indian Village Waste Water Treatment Plant
Remediation Parameters

Sample ID	Sample Date	Depth	Percent Water	pH
		CRQL	0	0
		Units	PERCENT	PH UNITS
IVW-SD01S-01	11/4/95	1	15	6
IVW-SD02S-01	11/4/95	1	12	6.3
IVW-SD03S-01	11/4/95	1	42	6.4
IVW-SS01S-01	11/4/95	1	3.4	7.3
IVW-SS02S-01	11/4/95	1	3.7	7.2
IVW-SS03S-01	11/4/95	1	3.6	7.7
IVW-SS04S-01	11/4/95	1	4.6	7.4
IVW-SS05S-01	11/4/95	1	5.9	7.5

Indian Village Waste Water Treatment Plant
Nitrogen Compounds

Sample ID	Sample Date	Depth	Ammonia as N	Nitrate plus Nitrite as N
		CRQL	0.5	0.5
		Units	mg/kg	mg/kg
IVW-SD01S-01	11/4/95	1	<0.4	15.6
IVW-SD02S-01	11/4/95	1	<0.4	5.1 U
IVW-SD03S-01	11/4/95	1	<0.4	<0.05
IVW-SS01S-01	11/4/95	1	<0.4	30
IVW-SS02S-01	11/4/95	1	<0.4	2.1 U
IVW-SS03S-01	11/4/95	1	<0.4	1.8 U
IVW-SS04S-01	11/4/95	1	<0.4	2.3 U
IVW-SS05S-01	11/4/95	1	<0.4	1.9 U

Analyses	8	8
Detections	0	7
Maximum Concentration	0	30
Arizona HBGL - Nonresidential		665000
Arizona HBGL - Nonresidential Hits		0

Indian Village Waste Water Treatment Plant
Metals

Sample ID	Sample Date	Depth	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Lead, Total	Mercury, Total	Potassium, Total	Selenium, Total	Silver, Total
		CRQL	0.5	2	0.2	0.2	0.5	0.5	0.2	500	0.5	0.5
		Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
IVW-SD01S-01	11/4/95	1	6.8	524	1.8	0.6	57.2	25.1	0.52	2620	0.8	0.34 J
IVW-SD02S-01	11/4/95	1	9.4	495	1.8	<0.1	50.1	12.9	<0.033	1830	3.6	<0.2
IVW-SD03S-01	11/4/95	1	4.2	422	1.4	<0.05	62.2	14.4	0.084 J	2530	0.55 J	<0.1
IVW-SS01S-01	11/4/95	1	2.3	69.4	0.34	0.3 U	10	19	0.13 J	731	<0.3	0.3 J
IVW-SS02S-01	11/4/95	1	2.9	49.8	0.24	0.099 U	9	9.9	0.057 J	472 J	<0.3	<0.1
IVW-SS03S-01	11/4/95	1	1.7	55.1	0.25	0.076 U	9	9.6	0.061 J	463 J	<0.3	<0.1
IVW-SS04S-01	11/4/95	1	2.9	88.7	0.38	0.23 U	9.9	11.3	0.14 J	637	0.4 J	0.32 J
IVW-SS05S-01	11/4/95	1	3.3	89.1	0.5	0.26 U	14.2	14.3	0.14 J	919	0.41 J	0.45 J

	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Lead, Total	Mercury, Total	Potassium, Total	Selenium, Total	Silver, Total
Analyses	8	8	8	8	8	8	8	8	8	8
Detections	8	8	8	6	8	8	7	8	5	4
Maximum Concentration	9.4	524	1.8	0.6	62.2	25.1	0.52	2620	3.6	0.45
Arizona HBGL - Nonresidential	3.82	28700	1.34	244	5950	1400	123		2030	2030
Arizona HBGL - Nonresidential Hits	3	0	3	0	0	0	0		0	0
Maximum Background Concentration	44	1610	5	1.5	90	30	0.3	0	0.8	2.6
Background Hits	0	0	0	0	0	0	1	0	1	0

Indian Village Wastewater Treatment Plant
Remedation Parameter Water

Sample ID	Sample Date	Depth	pH
		CRQL Units	PH UNITS
IVW-WC01W-01	11/4/95		9
IVW-WC02W-01	11/4/95		9.2

Indian Village Waste Water Treatment Plant
Nitrogen Compounds Water

Sample ID	Sample Date	Depth	Ammonia as N		Nitrate plus Nitrite as N	
		CRQL	300		50	
		Units	ug/L		ug/L	
IVW-SW03W-01	11/2/95		110	J	28	U
IVW-SW04W-01	11/2/95		110	J	17	U
IVW-SW05W-01	11/2/95		<70		35	U
IVW-WC01W-01	11/4/95		180	J	29	U
IVW-WC02W-01	11/4/95		120	J	280	U

Analyses	5	5
Detections	4	5
Maximum Concentration	180	280
Arizona HBGL		11000
Arizona HBGL Hits		0
AWQS		10000
AWQS Hits		0

Indian Village Waste Water Treatment Plant
Metals Water

Sample ID	Sample Date	Depth	Arsenic, Total	Barium, Total	Beryllium, Total	Cadmium, Total	Chromium, Total	Lead, Total	Mercury, Total	Potassium, Total	Selenium, Total	Silver, Total
		CRQL	5	20	2	2	5	5	0.5	5000	5	5
		Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
IVW-SW03W-01	11/2/95	0	<3	229	<0.5	<0.5	4.4 U	3.2 U	<0.2	2320 J	<3	<1
IVW-SW04W-01	11/2/95	0	<3	8.7 J	<0.5	<0.5	1.7 U	6.7 U	<0.2	2770 J	<3	<1
IVW-SW05W-01	11/2/95	0	<3	8.9 J	<0.5	<0.5	1.7 U	6.1 U	<0.2	2770 J	<3	<1
IVW-WC01W-01	11/4/95	0	<3	67.2 J	<0.5	<0.5	1.5 J	29.4 J	0.81 J	3090 J	<3	<1
IVW-WC02W-01	11/4/95	0	4.6 J	252 J	0.63 J	0.64 J	17.3 J	81.2 J	2.1 J	4720 J	4.9 J	2.1 J

Analyses	5	5	5	5	5	5	5	5	5	5
Detections	1	5	1	1	5	5	2	5	1	1
Maximum Concentration	4.6	252	0.63	0.64	17.3	81.2	2.1	4720	4.9	2.1
Arizona HBGL	0.02	490	0.008	3.5	100	5	2.1		35	35
Arizona HBGL Hits	1	0	1	0	0	4	1		0	0
AWQS	50	2000	4	5	100	50	2		50	
AWQS Hits	0	0	0	0	0	1	1		0	

APPENDIX F

SOIL PHYSICAL CHARACTERISTICS

APPENDIX G

QUANTERRA CERTIFICATES OF ANALYSIS

Note: Certificates of Analysis are not included in the Final Reports. Certificates of Analysis will be provided in select copies of the Final Report. For access to a complete copy of the Certificates of Analysis, please contact the Camp Navajo Environmental Office at (520) 773-3208.

APPENDIX H

Morrison Knudsen, Corp.
Closure Report for Reallocated Work

Note: Only sections that pertain to the Former Chemical Lab are included in this Appendix.

APPENDIX I

SCOPE OF WORK